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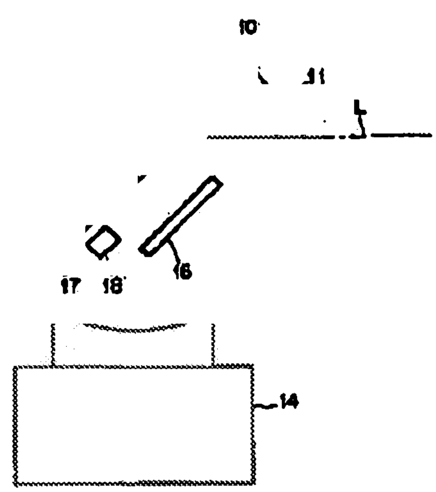
(54) FORMATION OF THIN FILM

(57)Abstract:
PURPOSE: To control the thin film forming rate on a substrate without changing the power of a laser light in the formation of thin film by laser abrasion method and to prevent the generation of a droplet.
CONSTITUTION: A laser beam L is introduced into a film forming chamber 10 from a window 11 to irradiate a target 15. A film forming material (atom, molecule and ion) is emitted from the target 15 by the irradiation with the laser light, deposited on a substrate 16 and crystallized to form a thin film. A mesh or grid-like passing area control sheet 17 is set between the target 15 and substrate 16. The film forming material passes through the opening of the sheet 17 and arrives at the substrate 16.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to a method for forming thin film and the method of depositing / crystallizing membrane formation material and forming a thin film on a substrate, by the laser ablation method, in detail.
[0002]
[Description of the Prior Art]It is good and the laser ablation method attracts attention as one of the methods of forming the thin film of the ferroelectric of high crystallinity and a high characteristic, and a piezo electric crystal. A solid target is irradiated with a pulse laser beam, and the laser ablation method deposits / crystallizes on a substrate the atom, molecule, and ion which were emitted, and forms a thin film as indicated to the 1244th page of the 12 No. (1993) with an applied physics of volume [62nd], and the 1245th page.
[0003]It is mainly based on the following reasons that this laser ablation method attracts attention.
(1) Since a laser beam is introduced from the exterior of a membrane formation room, the inside of a membrane formation room can be adjusted to atmosphere and a pressure suitable for crystal growth. (2) Since membrane formation material is emitted only from a target, a thin film without an impurity is obtained. (3) Parameters, such as a pressure, substrate temperature, and membrane formation speed, can be chosen independently.
[0004]And by the conventional laser ablation method, the power (an output, oscillating frequency) of the laser beam was changed to adjusting membrane formation speed. However, when the power of a laser beam is dropped on this adjustment method, the excitation energy to a target decreases, and the energy of the membrane formation material which reaches on a substrate also decreases. The crystallinity and stacking tendency of a thin film worsen now. When dividing a laser beam into two on the way and exciting a substrate by the laser beam of another side, if the power of a laser beam is changed, the energy of substrate excitation will also change and the crystallinity of a thin film and a stacking tendency will worsen at said the appearance.
[0005]On the other hand, in the laser ablation method, cluster particles are intermingled in the plume emitted from a target, and it has the fault (generating of a droplet) which this cluster particle deposits liquid drop-like into a thin film. Therefore, as shown in drawing 8, forming the shadow mask 3 between the target 1 and the

substrate 2 is proposed. The cluster particles with large mass which exists in the plume P collide with the mask 3, and do not reach the substrate 2, and generating of a droplet is prevented. Although a low-mass atom, a molecule, and ion particles turn around the mask 3 on the other hand and the substrate 2 is reached, the homogeneity of a thin film and homogeneity get worse in membrane formation by surroundings lump.

[0006]

[Objects of the Invention]Then, the purpose of this invention is to provide the method for forming thin film which can control the membrane formation speed on a substrate, and can prevent generating of a droplet without changing the power of a laser beam.

[0007]

[The composition, operation, and effect of an invention] In order to attain the above purpose, the method for forming thin film concerning this invention makes the membrane formation material emitted from the target reach on a substrate via the passage area control member which has many crevices.

[0008]Many crevices provided in a passage area control member have a size which can pass an atom, a molecule, and ion which were emitted from a target at least, and such membrane formation materials pass a crevice between control members, and reach on a substrate. Therefore, membrane formation speed on a substrate can be controlled by setting up a size of a crevice arbitrarily, without changing power of a laser beam, and aggravation of the crystallinity of a thin film by a power change of a laser beam and a stacking tendency is canceled. Since excitation energy of a substrate does not change even if it changes membrane formation speed when separating a laser beam and exciting a substrate by a laser beam of another side, especially this invention method is effective.

[0009]In this invention method, cluster particles which exist in a plume are caught in said crevice, and do not reach on a substrate, and fault of them which a droplet generates in a thin film is lost. And since membrane formation material does not turn around a shadow mask like the former, the homogeneity of a thin film and homogeneity are not spoiled.

[0010]

[Example]Hereafter, the example of the method for forming thin film concerning this invention is described with reference to an accompanying drawing.

[0011]Drawing 1 shows the laser ablation device used as the 1st example. This device introduces laser beam L emitted from the light source unit which installs the target 15 and the substrate 16 at the predetermined intervals in the membrane formation room 10, and is not illustrated in the membrane formation room 10 from the window part 11, and it is constituted so that it may irradiate with the target 15. The exhaust 14 for making the inside of the membrane formation room 10 into a vacuum and the gas supply device (not shown) which supplies gas, such as oxygen or ozone, in the membrane formation room 10 are attached.

[0012]In the membrane formation room 10, the two passage area control boards 17 are installed between the target 15 and the substrate 16. This control board 17 makes the shape of a lattice shown in the mesh state shown in drawing 2, or drawing 3, and is pivotable 180 degrees at a time by the rotary drive 18. That is, the control board 17 can move between the target 15 and the substrate 16 in [that from which the size of a mesh and the size of a lattice differ] exchange. As for the installation number of sheets in the case of

using it in this way, switching the control board 17, three sheets or at least four sheets are possible.
[0013]Materials, such as ZnO, $LiNbO_3$, PZT, and PLZT, are used as the target 15. As the substrate 16, materials, such as glass, sapphire, a Si wafer, single crystal $LiNbO_3$, single crystal $Li_2B_4O_7$, and single crystal $LiTa_2O_5$, are used. The control board 17 is formed from materials, such as stainless steel, aluminum, and ceramics. The crevice between the control boards 17 needs to be larger than the particle diameter of the membrane formation material emitted from the target 15 at least. For example, in the case of the mesh state shown in drawing 2, the sizes of a mesh are 440 meshes (bore diameter of 32 micrometers) - a 140-mesh (bore diameter of 106 micrometers) grade. In the case of the shape of a lattice shown in drawing 3, it is arbitrarily [among 10-100 micrometers] selectable in lattice width and a lattice spacing.
[0014]In the above laser ablation device, if laser beam L irradiates with the target 15, the granule child who are membrane formation materials, such as an atom, a molecule, and ion, will be emitted from the target 15, and the plume P will be formed. The emitted membrane formation material passes the crevice between the control boards 17, and it is deposited on the substrate 16 and it crystallizes it. Membrane formation speed is controlled with the quantity in which membrane formation material passes the control board 17, i.e., the through put per unit time. This through put is chiefly based on the size of the crevice between the control boards 17.
[0015]What kind of control board is used makes a thin film as an experiment in a preparatory step using various control boards, and it chooses the control board which has formed the most desirable thin film.
[0016]It can be set as the most desirable membrane formation speed by choosing the control board 17, and the power of a laser beam can be changed, it is not necessary to control membrane formation speed, and, according to the 1st example described above, the good thin film of crystallinity and a stacking tendency can be obtained. Since the cluster particles with large mass which exists in the plume P adhere to the control board 17, it does not reach on the substrate 16 and generating of a droplet is prevented. In order to prevent a surroundings lump of membrane formation material, as for the size of the control board 17, it is preferred that it is equivalent to a target at least, and it can secure the homogeneity of a thin film, and homogeneity by this condition. A minute vibration may be given to the control board 17 if needed. Delicate control of membrane formation speed is possible also by a period of vibration and amplitude, and the complementation of cluster particles improves by vibration.
[0017]The control board 17 may be installed in multistage. It is delicately controllable by installing in multistage, the through put, i.e., the membrane formation speed, per unit time of membrane formation material. Drawing 4 shows the case where the lattice-like control board 17 is formed in two steps. Membrane formation speed changes delicately by adjusting the quantity which can shift an up-and-down lattice.
[0018]It is [board / 17 / control] usable in the thing of various shape. For example, that to which drawing 5 made the crevice radiate, and drawing 6 show what made the crevice spiral. From the center, the size of a radiate and spiral crevice is a place of 70 percent of a radius, and is 10-100 micrometers. It may be made to rotate if it is in these control boards 17. When it is made to rotate, the size of a crevice is based on number of rotations, but it can be made 1000 micrometers. The complementation of cluster particles improves by making it rotate. The size of a crevice and control with a conjointly delicate membrane formation speed are possible by adjusting number of rotations.

[0019]Drawing 7 shows the laser ablation device used as the 2nd example. This device divides laser beam L into two with the half mirror 21. One laser beam L_1 irradiates with the target 15 through the window part 11. It is reflected by the mirrors 22 and 23, and laser beam L_2 of another side irradiates with the substrate 16 through the window part 12, and excites the substrate 16. What was shown in drawing 3 as the control board 17 was installed in two steps. The numerals 19 are the drives for changing the amount of gaps of the lattice of the control board 17, or making it vibrate.

[0020]Since it is not necessary to change the power of a laser beam into control of membrane formation speed if this invention is applied to such a laser beam discrete type, the excitation energy of the substrate 16 can be maintained to a regular predetermined value, and it does not have an adverse effect on the crystallinity or stacking tendency of a thin film.

[0021]the method for forming thin film concerning this invention is not limited to said example, within the limits of the gist, can be boiled variously and can be changed. Especially the construction material of a control board, composition, shape, the size of a crevice, etc. can be arbitrarily chosen according to the membrane formation speed made into the kind of membrane formation material, or the purpose.

[Translation done.]